



Original Article

Psychometric properties and clinical relevance of the Adolescent Sleep Hygiene Scale in Dutch adolescents

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ABSTRACT

Objective: This study investigated reliability, validity, and clinical relevance of the Adolescent Sleep Hygiene Scale (ASHS) in Dutch adolescents.

Methods: The Dutch translation of the ASHS was administered to 186 normal-sleeping adolescents and 112 adolescents with insomnia. Their sleep variables were measured using sleep logs and questionnaires. From the insomnia group, scores were also obtained after six weeks of cognitive behavioral therapy for insomnia ($n = 58$) or waiting list ($n = 22$).

Results: The full scale of the ASHS had acceptable internal consistency. The results showed moderate to strong correlations of the ASHS (domains) with sleep quality, sleep duration and chronic sleep reduction. Furthermore, the Dutch ASHS was able to discriminate between normal sleepers and adolescents with insomnia, and scores of adolescents with insomnia improved after treatment.

Conclusions: These findings confirm the importance of sleep hygiene in adolescent sleep, and contribute to the validity of the ASHS and its applicability in research and clinical practice.

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1. Introduction

Sleep hygiene refers to a set of practices that promote adequate sleep duration, good sleep quality, and daytime alertness [1]. It includes guidelines for several aspects of life, such as general health practices (eg, exercise), environmental factors (eg, light), and sleep-related behaviors (eg, establishing a regular sleep schedule) [2].

Previous research has addressed the association between adolescent sleep hygiene and other sleep-related variables and aspects of daily functioning, such as daytime sleepiness. LeBourgeois et al. [1] demonstrated a moderate association between self-reported sleep hygiene and sleep quality in 776 Italian and 572 American public school students aged 12–17 years. They found that the cognitive and the emotional components of sleep hygiene are the strongest unique predictors of overall sleep quality. Similar results were found by Manni et al. [3] in 869 17-year-old Italian students. Brown et al. [4] showed that sleep–wake schedule irregularity, going to bed thirsty, environmental noise, and worrying while falling asleep contributed to poor sleep quality in 124 American

undergraduate students. Again cognition, more specifically worry, was found to play an important role in poor sleep quality.

The association of sleep hygiene with sleep duration is less distinct. Regularity of the sleep–wake schedule is a sleep hygiene practice that has often been emphasized with respect to sleep duration, as it takes the adolescent circadian timing system a long time to shift back to an early sleep–wake cycle after a weekend of delayed bedtimes and sleeping in [5]. Storfer-Isser et al. [6] confirmed this assumption in a study with 514 American adolescents, showing small but positive associations with sleep duration as measured by actigraphy.

Several aspects of daily functioning also appeared to be related to sleep hygiene. Sleep hygiene was modestly related to perceptions of daytime sleepiness [6,7]. Finally, adolescents with poor sleep hygiene showed significantly lower school competency scores, higher problem scores, and worse grades [6,8]. The associations of sleep duration and sleep quality with adolescent problem behavior [9] justify the assumption that sleep hygiene is related to daytime functioning.

The Adolescent Sleep Hygiene Scale (ASHS) [1] and its revised form (ASHS-r) [6] are the only sleep hygiene measures for use in adolescents. The ASHS has been rated as ‘approaching well-established’ [10] according to the criteria for evidence-based pediatric sleep measures [11]. The reason for this rating is its moderate validation information.

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Because sleep hygiene consists of practices that promote sleep quality and sleep duration, it is a plausible hypothesis that sleep hygiene plays a role in insomnia. Several studies compared the practice of sleep hygiene in insomnia patients and good sleepers. In a study comparing three groups of 18 adults each, with psychophysiological insomnia, insomnia associated with depressive disorder, and good sleepers, Kohn and Espie [12] concluded that patients with insomnia engage in significantly more habits that demote sleep and are characterized by heightened mental arousal at bedtime. In a study with 144 adults Lacks and Rotert [13] compared patients with sleep onset insomnia and sleep maintenance insomnia with good sleepers and found that patients with insomnia had more general sleep hygiene knowledge than good sleepers, but practiced it less often. Jefferson et al. [14] even found several maladaptive sleep hygiene practices to be predictors of insomnia in a population-based sample of 258 patients with insomnia and 258 normal sleepers. However, even though patients with insomnia were found to engage in less adequate sleep hygiene practices, a less straightforward association was found between sleep hygiene and sleep quality in this group. Yang et al. [2] only found a correlation between the domain of arousal-related behaviors of sleep hygiene and sleep difficulties in 106 patients with insomnia compared with 89 good sleepers. Stepanski and Wyatt [15] concluded from a literature review spanning 24 years of sleep hygiene practice that there are no empirical data demonstrating the role of poor sleep hygiene in insomnia or showing that good sleep hygiene improves sleep in patients with insomnia. All studies mentioned above concerning sleep hygiene and insomnia were conducted with adults. Concerning adolescents, Malone [16] concluded in a literature review that evidence for the applicability of sleep hygiene practices is questionable. Therefore the role of sleep hygiene in insomnia does not seem distinct. Nevertheless, since previous research has noted the association between sleep hygiene and sleep quality and sleep duration, more research on this topic is needed.

The present study aimed to examine the psychometric properties of the translated version of the ASHS in Dutch adolescents and to examine scores in samples of normal sleepers and adolescents with insomnia. Based on the results of previous research, we expect that sleep hygiene scores from the ASHS correlate positively with sleep quality and sleep duration and that they correlate negatively with daytime sleepiness, and in particular with chronic sleep reduction. Chronic sleep reduction has been demonstrated to have negative effects on daytime functioning [8,17].

Since the importance of the cognitive and emotional aspects of sleep hygiene has been emphasized by multiple studies [1,3,4], strong correlations between these aspects of sleep hygiene and the sleep-related variables are expected.

Furthermore, we aim to explore the role of sleep hygiene in adolescents with insomnia by comparing their sleep hygiene practices with a community sample, and by comparing the effects of cognitive behavior therapy for insomnia (CBT-I) on sleep hygiene between a waiting list group and a group of adolescents receiving CBT-I. Improvement of sleep hygiene scores in the CBT-I group indicates the validity of sleep hygiene in insomnia in adolescents and its importance for treatment.

2. Methods

2.1. Participants

A community sample of adolescents and a sample of adolescents with insomnia were recruited. The community sample consisted of 186 participants, 58 (31%) male and 128 (69%) female, recruited from two secondary schools in Amsterdam, The Netherlands. Age ranged from 12:6 to 19:8 years (mean, 14:4 years).

Thirty-six percent of the children were in their first year of secondary school, 24% in the second year, 27% in the third and 13% in the fourth.

Because not all adolescents in the community sample reported as good sleepers, for further analysis this group was divided into good sleepers and poor sleepers. Participants who reported sleeping badly at least once or twice a week were labeled as poor sleepers.

The second group consisted of adolescents with a diagnosis of insomnia, recruited through the media and youth healthcare centers. After registering through an online website, these participants received an e-mail outlining the aims and procedures of the study. Inclusion criteria were: (i) age 12–19 years; (ii) insomnia complaints according to the DSM-IV-TR criteria for primary insomnia [18] as indicated by scores above cut-off on the insomnia scale of the Holland Sleep Disorder Questionnaire (HSDQ) [19] and confirmed by information from the intake interview; (iii) no suicidal intentions or drug abuse, investigated through clinical scores and item screening on the Youth Self Report [20] and information from the intake interview; (iv) no indication of sleep disorders other than insomnia indicated by scores above cut-off on other scales from the HSDQ and confirmed with information from the intake interview; (v) not presently being treated for psychological or sleep problems; and (vi) no use of drugs or medication that interferes with sleep. From the initial 417 adolescents who registered online, 276 withdrew from the study for: no reason given (51.4%); already under psychological or medical treatment (for sleep or other problems) (8.1%); too busy in school or otherwise (9.4%); too young (4.0%); or too old (27.1%). From the 141 adolescents who were interviewed by an academically trained and experienced sleep specialist, 29 were excluded from the study: four withdrew with no reason given, nine were excluded because of strong indications of a delayed sleep phase syndrome and were referred to a specialized clinic for further diagnosis and treatment, nine were starting other treatments, and seven indicated that they did not have sufficient time or motivation to engage in the treatment. There were 112 adolescents with insomnia included in the study, of which 25 (22%) were male and 87 (78%) female. Age (years:months) ranged from 12:4 to 19:11 (mean, 15:9). Ten percent were in their first year of secondary school, 14% in their second, 22% in their third, 25% in their fourth, 13% in their fifth, 3% in their sixth; and 13% were in post-secondary education.

The participants with insomnia in this study were recruited for the clinical trial registered with ISRCTN registration number: ISRCTN33922163.

2.2. Procedure

After recruitment, participants received information on the study and informed consent was obtained from adolescents and their parents.

In the community sample, participants were given 40 min to complete the questionnaires individually in a classroom setting, after a short instruction by the researcher. In the questionnaires, participants also answered questions on socio-economic status (SES), age, and gender. Afterwards, they received a sleep log form and were instructed to register their sleep during a period of 14 days. The Dutch translation of the ASHS was included at the end of the sleep log.

Participants in the insomnia sample registered through a website with a questionnaire on their initial sleep complaint, SES details and contact information. After obtaining informed consent, they filled out the questionnaires and sleep logs online. These participants were then diagnosed for primary insomnia according to the DSM-IV-TR in a face-to-face 1 h interview. This group of adolescents with insomnia was recruited for another study into

efficacy of Internet and group-administered CBT-I which was approved by the medical ethics committee of the Academic Medical Center in Amsterdam. A further description of the procedure for diagnosis and inclusion may be found elsewhere [21].

Of the participants in the insomnia sample, 58 had received CBT-I consisting of six weekly sessions from trained sleep psychotherapists with either group therapy or Internet therapy, containing psycho-education and sleep hygiene, stimulus control, restriction of time in bed, stress reduction and relaxation, and cognitive therapy. Using two different modes of treatment improves generalizability of treatment effects on sleep hygiene. A study on efficacy for CBT-I in adolescents indicated that both these modes of treatment have similar effectiveness in decreasing insomnia complaints and improving sleep variables. For a detailed description on the protocol and efficacy, see De Bruin et al. [21]. From the insomnia group, 22 participants were put on a waiting list.

2.3. Measures

2.3.1. Adolescent Sleep Hygiene Scale (ASHS)

The ASHS [1] is a 28-item self-administered instrument that assesses along nine domains the degree to which adolescents (aged 12–18 years) apply sleep hygiene practices (Appendix 1).

All 28 questions are answered on a six-point scale, ranging from always (1) to never (6), with higher scores indicating more adequate sleep hygiene practices. For the English ASHS, acceptable internal consistency was found, with Cronbach's α of 0.80 for the full scale and less convincing reliabilities for the different domains, ranging from 0.46 to 0.74 [1].

Recently a revised version of the ASHS, the ASHS-r, was published [6]. A few minor changes were made to the ASHS-r: one item was added to the daytime sleep domain ('After 6 p.m. in the evening, I take a nap'); one item was added to the sleep stability domain ('I fall asleep in one place and then move to another place during the night'); and the bed/bedroom sharing domain and the two items that comprise it were omitted. Finally, a new cognitive-emotional scale was composed consisting of six items (the original emotional scale and three items from the cognitive scale). Cronbach's α for the total ASHS-r was 0.84 and ranged for the different domains from 0.60 to 0.81 [6].

2.3.2. Sleep duration

Sleep duration was measured by a questionnaire consisting of questions about bedtimes and wake-up times during school nights [22].

For more exact information about sleep duration, participants kept a daily sleep log to register their bedtimes, light-out times, wake-up times, and get-up times for a period of 14 days. The light-out time was used in calculating sleep duration. Average sleep duration on the sleep log was assessed separately for weekdays and weekend days. For every participant, sleep durations of all school or weekend nights were summed and afterwards divided by the number of nights. The correlation coefficient between the sleep duration during a school week as reported on the sleep questionnaire and the average sleep duration during a school week as registered on the sleep log was 0.80.

2.3.3. Sleep quality

The sleep quality scale comprises seven questions that are answered on a three-point scale. The minimum score on this scale is seven and the maximum is 21. Higher scores reflect better sleep quality and reliabilities appeared satisfactory [22,23]. Reliability in the present study was $\alpha = 0.65$.

For a more specific, day-to-day, assessment of sleep quality the sleep log was used. Every morning, participants answered six yes/

no questions regarding sleep quality (e.g., 'Did you feel rested when you woke up?'). Higher scores reflect better sleep quality. Sleep quality on the sleep log was assessed separately for school nights and weekend nights. Sleep quality values of every school night were summed and subsequently divided by the number of nights. The association between sleep quality reports on the questionnaire and average sleep quality registered on the sleep log during school nights was $r = 0.67$.

2.3.4. Chronic sleep reduction

The Chronic Sleep Reduction Questionnaire (CSRQ) [23] consists of 20 questions with three ordinal response categories, therefore the minimum score is 20 and the maximum is 60. Higher scores indicate more chronic sleep reduction. The CSRQ comprises four subscales: Shortage of Sleep, Irritability, Loss of Energy, and Sleepiness. Both inter-item reliability (Cronbach's $\alpha = 0.83$) and test-retest reliability ($r = 0.76$) [23] and the construct validity of the questionnaire were found to be satisfactory [24]. Reliability of the CSRQ in the current study was $\alpha = 0.79$.

2.4. Statistics

The ASHS data were analyzed in several ways to examine the psychometric properties of the Dutch ASHS as broadly as possible. Missing values were imputed on item level using the expectation maximization method [25]. From the 186 participants in the community sample, 23 showed 1–3 missing values on the ASHS items. Two participants had more than 15 missing values. Because the other questionnaires were nearly complete, we included these participants' data in the dataset. Principal component analysis (PCA) was done with and without outliers [26]. Outlier inspection was first done on the total ASHS score. Scores were normally distributed around the mean (skewness: -0.298 ; kurtosis: -0.243), and no outliers were present. Hereafter, the same was done on item level. Scores for ASHS items that showed strikingly small variance or extreme skewness, with the mean score approaching the minimum or maximum score, were removed from the dataset. In order to obtain a complete dataset, missing value analysis was again performed. No information provided by PCA yielded distinct differences between the results from original data and results from data with replacements after item removal. Furthermore, the relations of ASHS total score to socio-demographic variables and to internal consistencies were similar in both datasets. Therefore, all analyses were done on the original dataset.

Concurrent validity of the ASHS was assessed by examining the correlations between ASHS and sleep-related factors that have been demonstrated to be associated with sleep hygiene, with r -values of around 0.10, 0.30 and 0.50 indicating weak, moderate, and strong correlations [27]. For computation of these psychometric properties, only the data from the community sample were used.

In order to assess whether the ASHS can discriminate between a clinical group and a normative sample, analyses of variance (ANOVA) were performed with the community sample and the insomnia sample together. Improvements of ASHS scores after treatment for the insomnia group were analyzed with ANOVA of the difference between scores at baseline and after six weeks of either treatment or waiting list (i.e., post-treatment scores minus baseline scores), with higher scores indicating more improvement. In the insomnia group there were no missing values for the ASHS because the questionnaire was filled out online and missing responses were identified before participants submitted the questionnaire.

For all results from ANOVA and post-hoc tests, we calculated corrected Cohen's d effect sizes, with 0.20, 0.50, and 0.80 indicating small, medium, and large effect sizes, respectively [27,28].

3. Results

3.1. Descriptives

In the community sample, sleep duration on school nights as assessed by the sleep questionnaire ranged from 05:45 to 10:30 (mean, 08:39; SD, 0:52). Average sleep duration on school nights as registered on the sleep log ranged from 06:09 to 10:13 (mean, 08:39; SD, 00:44) and in the weekend from 05:10 to 11:40 (mean, 09:20; SD, 01:01).

The total score on the ASHS was not associated with gender [$t(1, 184) = 1.41, P = 0.16$], age ($r = -0.128, P = 0.09$), marital status of the parents [$F(2, 182) = 1.74, P = 0.18$], employment of one, two, or no parent(s) [$F(2, 182) = 1.26, P = 0.29$], number of siblings ($r = 0.01, P = 0.91$), father's [$F(5, 137) = 0.60, P = 0.70$] or mother's [$F(4, 141) = 2.06, P = 0.09$] level of education, father's [$t(1, 181) = -0.62, P = 0.54$] or mother's [$t(1, 183) = -0.37, P = 0.71$] country of birth.

In the insomnia group, sleep duration registered by sleep logs ranged from 05:43 to 10:40 (mean, 07:29; SD, 00:53) on school nights and from 04:45 to 10:38 (mean, 08:11; SD, 01:18) on weekend nights.

3.2. Skewness

Examining the normality of the distribution of item scores led to the conclusion that 12 items (Appendix 1) showed extreme skewness, with the mean score almost reaching the minimum or maximum score. Because change of meaning due to translation or cultural factors can be involved in skewness of items, we investigated these aspects. During the active (from English to Dutch) and passive (from Dutch to English) translation process we met with no specific problems in the item translations. Concerning the skewed items in particular, it can be concluded that the item 'I go to bed feeling upset' has a strong emotional connotation. In the Dutch translation, it has the same strong connotation and so it would not be surprising that only 11% of adolescents answered with always to sometimes. The question 'During the 1 h before bedtime, things happen that make me feel strong emotions (sadness, anger, excitement)' showed that only 1.6% of the adolescents experienced these emotions always to sometimes. The correlation (Spearman's r) between these emotional questions was 0.52, suggesting a high congruence between both answers. Concerning the sleep environment questions about listening to loud music and falling asleep in a brightly lit room, cultural factors might play a role. Most houses in The Netherlands are small with neighbors close by, and playing loud music is not tolerated. Turning of the light is generally advocated to save energy. Concerning falling asleep while watching television, only half of adolescents have a television in their bedroom (in Amsterdam: 45.7% [29]; in the USA: 55.9% [30]). These percentages might explain the skewness of the answers on the television question. The same might apply to napping, substance use, bedroom sharing, and weekend sleep. With reference to daytime napping, Malone [16] remarked that daytime napping varies across time and between cultures. In The Netherlands, daytime napping is not prevalent among adolescents. With reference to the substances, we compared the answers on the ASHS with two other questions that were posed to the participants in the present study. Concerning smoking, 88.7% reported not smoking at all, 7% sometimes, and 2.7% often (missing values, 1.6%). For drinking alcohol, these values were 40.3% not at all, 51.1% sometimes, 5.9% often (missing values, 2.7%). Concerning bedroom sharing, most children in The Netherlands have their own bedroom (83%) [31]. In this study, 90.3% slept alone. In the revised ASHS the bedroom-sharing items are removed. Getting up much later than usual and sleeping in during weekends

compared with weekdays is a general phenomenon among adolescents in many countries. Gradisar et al. [32] reported a mean delay of 2½ h during weekends worldwide. In the present study, the mean delay was 3 h. The general absence of sleeping in at least 1 h past the usual bedtime during the school week might depend on the school start times in The Netherlands. Compared to other countries, school start times are later (at about 08:30). Besides, most adolescents live in the neighborhood of their school.

Summarizing these findings, it can be concluded that most of the skewness may be attributed to the low occurrence of the studied behavior (going to bed feeling upset, falling asleep while watching television, napping, smoking, drinking alcohol, bedroom sharing) or just a high prevalence of it (sleeping in and staying up at least 1 h later than usual in weekends). Only listening to loud music, falling asleep in a brightly lit room, and sleeping in during school weeks might be explained by cultural/environmental factors.

3.3. Internal consistency reliability

The Dutch ASHS yielded Cronbach's $\alpha = 0.67$. Since nine conceptual domains were defined in the ASHS, reliability was evaluated for those nine domains on the Dutch translation of the ASHS in the current study. Cronbach's α ranged from 0.26 to 0.82. Only the cognitive and the bed/bedroom-sharing domains showed sufficient reliability.

3.4. Principal component analysis

Prior to the PCA, the dataset for the current study was assessed as to whether it may be suitable for factor analysis. The correlation matrix demonstrated several coefficients ≥ 0.3 . However, the vast majority of the coefficients was < 0.3 . Nevertheless, factorability was demonstrated by an acceptable Kaiser–Meyer–Olkin value [33] of 0.61 and by Bartlett's test of sphericity, which reached significance.

PCA was first performed with a fixed number (nine) of components in order to explore whether the nine conceptual domains of LeBourgeois et al. [1] were represented in the factor structure of the Dutch ASHS. This analysis demonstrated that nine components, all with eigenvalues > 1 , jointly explained 58.35% of the variance. However, interpretation of these factors after Varimax rotation resulted in only minimal resemblance to the nine-domain structure. Only the 'bed/bedroom sharing' and the 'substances' domains were recognized as underlying constructs in our sample. A different factor was composed of all the items from the 'emotional' domain and three items from the 'cognitive' domain ('I go to bed and think about things I need to do', 'I go to bed and replay the day's events over and over in my head', and 'I check my clock several times during the night'). Interestingly, these same items were used in the ASHS-r to create the new subscale cognitive–emotional [6]. The subscale cognitive/emotional reflected good internal consistency ($\alpha = 0.75$).

It was concluded that a nine-component solution is optimal, since this yields three interpretable components, including the cognitive–emotional factor that keeps appearing irrespective of the number of factors requested, and since an acceptable percentage of variance is explained by nine components. Except for the cognitive/emotional subscale, two other subscales were identified: bed/bedroom sharing and substances.

3.5. Concurrent validity

All the correlations between the total ASHS score and sleep quality and sleep duration, as measured by questionnaire and sleep logs, and chronic sleep reduction, were in the expected direction (Table 1). Correlations with weekend sleep quality and sleep

Table 1
Significant correlations between Adolescent Sleep Hygiene Scale (ASHS) scores and sleep-related variables.

ASHS	Sleep quality week, questionnaire	Sleep quality week, sleep log	Sleep quality weekend, sleep log	General sleep quality, sleep log	Sleep duration week, questionnaire	Sleep duration week, sleep log	Sleep duration weekend, sleep log	General sleep duration, sleep log	Total CSRQ score	Shortage of sleep subscale	Irritability subscale	Energy loss subscale	Sleepiness subscale
Total ASHS score	0.40**	0.33**	0.22**	0.33**	0.38**	0.29**	0.16*	0.29**	-0.45**	-0.29**	-0.26**	-0.35**	-0.36**
Physiological	0.17*								-0.19*				-0.21*
Cognitive	0.35**	0.37**	0.29**	0.39**	0.17*				-0.20**	-0.21*	-0.15*		-0.22**
Emotional	0.35**	0.33**	0.30**	0.36**	0.20*	0.21*		0.18**	-0.42**	-0.21*	-0.38**	-0.34**	-0.24**
Sleep environment					0.29**	0.23**	0.15*	0.24**	-0.27**	-0.21*		-0.20**	-0.22**
Daytime sleep					0.24**	0.24**	0.22**	0.28**	-0.35**	-0.22*		-0.31**	-0.38**
Substances					0.32**	0.33**		0.31**	-0.35**	-0.26**		-0.35**	-0.30**
Bedtime routine	0.16*								-0.24**		-0.18*		-0.20**
Sleep stability	0.16*	0.20**		0.15*	0.17*					-0.15*			
Bedroom sharing													
Cognitive/emotional scale ^a	0.40**	0.41**	0.38**	0.45**	0.20**	0.18*		0.15*	-0.38**	-0.17*	-0.29**	-0.31**	-0.29**

CSRQ, Chronic Sleep Reduction Questionnaire.

^a The cognitive/emotional scale is identical to the scale of the same name in the ASHS-r.* $P < 0.05$ (two-tailed).** $P < 0.01$ (two-tailed).

duration appeared to be the lowest. The physiological domain was only slightly related to sleep quality as measured by questionnaire, and to chronic sleep reduction. Less cognitive and emotional arousal was related to better sleep quality and sleep duration and to lower chronic sleep reduction. Better sleep environment, less daytime sleep (naps), and less substance use were not related to sleep quality, but did show moderate relations with sleep duration and chronic sleep reduction. Bedtime routine was only slightly related to sleep quality as measured with the questionnaire and chronic sleep reduction. Better sleep stability showed weak associations with sleep quality and sleep duration as measured by questionnaire.

The cognitive-emotional scale, also described in the ASHS-r, showed moderate to strong associations with sleep quality, sleep duration (with the exception of sleep duration at the weekend, measured by sleep logs), and chronic sleep reduction.

3.6. Discriminating between normal sleepers and adolescents with insomnia

Means, standard deviations, and results from the ANOVA of ASHS scores from the community sample and the insomnia group are presented in Table 2. ANOVA yielded a significant difference in ASHS total scores for the community sample and the insomnia group, with the insomnia group obtaining a lower score. Adolescents with insomnia thus experienced more worry and emotions at bedtime, and scored lower on the sleep stability domain. By contrast, adolescents with insomnia scored higher on the bedtime routine domain than normal sleepers, but this was not significant.

For a more in-depth analysis, we compared the insomnia group with the good and poor sleepers (sleeping badly at least once or twice a week) of the community sample. Means, standard deviations and results from the ANOVA and post-hoc tests of ASHS scores from the community sample, divided into poor and good sleepers, and the insomnia group are presented in Table 3. ANOVA yielded a significant between-group difference on the ASHS total score. Post-hoc analyses demonstrated that the ASHS total scores for good sleepers were significantly higher than those of adolescents with insomnia. However, the ASHS did not discriminate between adolescents with insomnia and poor sleepers. Although poor sleepers had the lowest total ASHS scores of the three groups, the difference between good and poor sleepers from the community sample did not reach significance ($P = 0.11$).

Concerning the nine conceptual domains of the ASHS, post-hoc analyses demonstrated that the insomnia group engaged more in cognitive activity at bedtime than did good sleepers. Poor sleepers also engaged more in cognitive activity than did good sleepers, but this difference was not significant ($P = 0.07$). There was no difference in cognitive activity between adolescents with insomnia and poor sleepers. Furthermore, good sleepers were less emotional at bedtime than both poor sleepers and adolescents with insomnia, and there was no significant difference between poor sleepers and adolescents with insomnia. Adolescents with insomnia showed poorer daytime sleep practices than good sleepers, but this was not significant ($P = 0.08$). Interestingly, the insomnia group scored significantly higher on the bedtime routine than the poor sleepers, but there was no significant difference with the good sleepers. Finally, sleep stability was highest for the poor sleepers and lowest for adolescents with insomnia, with scores showing significant differences between good sleepers and adolescents with insomnia, and between poor sleepers and adolescents with insomnia, but not between good and poor sleepers (Table 3).

3.7. ASHS scores after treatment with CBT-I

From the insomnia group, 58 participants had concluded a CBT-I treatment of six weeks and 22 had been on a waiting list. For both

Table 2

Comparisons between Adolescent Sleep Hygiene Scale (ASHS) scores of adolescents with insomnia and normal sleepers.

ASHS	Insomnia (<i>n</i> = 112) Mean (SD)	Normal sleepers (<i>n</i> = 186) Mean (SD)	ANOVA (<i>F</i> , <i>df</i> = 1)	Effect size, Cohen's <i>d</i> ^a
Total ASHS	119.67 (12.77)	123.30 (10.35)	7.20**	0.31
Physiological	22.55 (3.05)	22.44 (3.12)	0.09	−0.04
Cognitive	19.65 (5.35)	21.35 (4.36)	8.85**	0.35
Emotional	13.14 (2.61)	14.41 (2.22)	19.82***	0.52
Sleep environment	21.19 (2.26)	20.96 (2.48)	0.63	−0.10
Daytime sleep	5.30 (1.13)	5.54 (0.86)	4.16*	0.24
Substances	11.36 (1.25)	11.31 (1.05)	0.10	−0.09
Bedtime routine	3.70 (1.67)	3.34 (1.47)	3.63	−0.23
Sleep stability	11.87 (3.65)	12.90 (2.92)	7.17**	0.31
Bed/bedroom sharing	10.91 (1.83)	11.06 (1.64)	0.51	0.09
Cognitive/emotional scale ^b	22.38 (5.02)	25.89 (4.56)	38.29***	0.73

ANOVA, analysis of variance.

^a Corrected Cohen's *d* effect sizes, with 0.20, 0.50, and 0.80 indicating small, medium, and large effect sizes, respectively [27,28]. Positive effect sizes indicate better sleep hygiene practices for the group of 'normal sleepers'.^b The cognitive/emotional scale is identical to the scale of the same name in the ASHS-r.* *P* < 0.05.** *P* < 0.01.*** *P* < 0.001.**Table 3**

Comparisons between Adolescent Sleep Hygiene Scale (ASHS) scores of adolescents with insomnia, poor sleepers and good sleepers.

ASHS	Insomnia group (<i>n</i> = 112) Mean (SD)	Normal sleepers in two groups		ANOVA main effect (<i>F</i> , <i>df</i> = 2)	Effect size Cohen's <i>d</i> ^a and post-hoc significance		
		Poor sleepers (<i>n</i> = 20) Mean (SD)	Good sleepers (<i>n</i> = 166) Mean (SD)		Insomnia group vs poor sleepers ^b	Insomnia group vs good sleepers ^c	Poor sleepers vs good sleepers ^d
ASHS	119.67 (12.77)	118.51 (11.01)	123.88 (10.15)	5.67**	−0.10	0.36**	0.50
Physiological	22.55 (3.05)	22.20 (3.11)	22.47 (3.13)	0.11	−0.11	−0.03	0.09
Cognitive	19.65 (5.35)	19.14 (4.54)	21.61 (4.28)	6.92**	−0.10	0.40**	0.55
Emotional	13.14 (2.61)	12.94 (2.60)	14.58 (2.12)	14.56***	−0.08	0.60***	0.68**
Sleep environment	21.19 (2.26)	20.44 (1.90)	21.02 (2.53)	0.83	−0.35	−0.07	0.26
Daytime sleep	5.30 (1.13)	5.38 (0.81)	5.56 (0.86)	2.38	0.08	0.26	0.21
Substances	11.36 (1.25)	11.05 (1.10)	11.35 (1.04)	0.67	−0.26	−0.01	0.28
Bedtime routine	3.70 (1.67)	2.76 (1.30)	3.41 (1.48)	3.40*	−0.62*	−0.18	0.46
Sleep stability	11.87 (3.65)	13.74 (3.70)	12.79 (2.81)	4.36*	0.50*	0.28*	−0.29
Bed/bedroom sharing	10.91 (1.83)	10.85 (1.63)	11.08 (1.64)	0.42	−0.03	0.10	0.14
Cognitive/emotional scale ^e	22.38 (5.02)	22.81 (4.95)	26.26 (4.39)	24.59***	0.09	0.82***	0.73**

ANOVA, analysis of variance.

^a Corrected Cohen's *d* effect sizes, with 0.20, 0.50, and 0.80 indicating small, medium, and large effect sizes, respectively [27,28].^b Positive effect sizes indicate better sleep hygiene practices for the group of poor sleepers compared to adolescents with insomnia.^c Positive effect sizes indicate better sleep hygiene practices for the group of good sleepers compared to adolescents with insomnia.^d Positive effect sizes indicate better sleep hygiene practices for the group of good sleepers compared to poor sleepers.^e The cognitive/emotional scale is identical to the scale of the same name in the ASHS-r.* *P* < 0.05.** *P* < 0.01.*** *P* < 0.001.

groups, scores on the ASHS were obtained after either treatment or waiting list. The CBT-I treatment has been shown to be effective to improve sleep of adolescents and treats several aspects of insomnia, among which are sleep hygiene practices [21]. Scores at baseline were subtracted from the scores after treatment to compute difference scores. Higher scores indicate greater improvement on the ASHS. ANOVA showed that after treatment the total score of the ASHS as well as the domain scores 'physiological', 'cognitive', 'emotional', 'daytime sleep', 'bedtime routine', and the new scale 'cognitive–emotional' improved more for the treatment group than for the waiting list (Table 4).

4. Discussion

This study explored the psychometric properties and clinical relevance of sleep hygiene in adolescents with the use of the Dutch

translation of the ASHS [1]. Concerning the validity of the Dutch ASHS, sufficient to good [34] psychometric properties were demonstrated for the full scale and the cognitive–emotional subscale. However, only two of the nine conceptual domains had satisfactory reliability. The factor structure was explored to assess whether the nine conceptualized domains were reflected in this structure. The factor analyses resulted in the formation of three subscales, of which two (bed/bedroom-sharing domain and the substances domain) corresponded to the domains suggested by LeBourgeois et al. [1]. The third subscale tapped items about worry and negative emotions and had good internal consistency. The rather large number of ASHS items with a skewed distribution might be due to not finding an adequate factor structure and sufficient reliability for the domains [35]. Whether cultural factors play a role cannot be concluded from the present study. However, low occurrence (e.g., smoking) or high prevalence (e.g., oversleeping in weekends) of

Table 4

Comparisons of difference scores from the Adolescent Sleep Hygiene Scale (ASHS) of adolescents with insomnia after cognitive behavioral therapy for insomnia or waiting list (higher scores signify more improvement).

ASHS	Waiting list (<i>n</i> = 22) Mean (SD)	Treatment (<i>n</i> = 58) Mean (SD)	ANOVA (<i>F</i> , <i>df</i> = 1)	Effect sizeCohen's <i>d</i> ^a
Total ASHS	2.05 (8.21)	10.90 (11.74)	10.52**	0.85
Physiological	−0.14 (2.75)	1.64 (3.03)	5.74*	0.60
Cognitive	1.91 (4.97)	5.00 (4.78)	6.54*	0.62
Emotional	−0.45 (2.30)	1.22 (2.16)	9.29**	0.73
Sleep environment	0.68 (1.81)	0.52 (1.67)	0.15	−0.09
Daytime sleep	−0.36 (0.85)	0.40 (0.92)	11.42*	0.84
Substances	−0.09 (0.68)	−0.05 (0.63)	0.06	0.06
Bedtime routine	−0.59 (1.68)	0.31 (1.50)	5.38*	0.55
Sleep stability	1.09 (4.46)	1.88 (4.07)	0.57	0.18
Bed/bedroom sharing	0.00 (1.31)	−0.20 (0.83)	0.01	−0.18
Cognitive/emotional ^b	1.32 (5.15)	4.24 (4.01)	7.21**	0.62

^a The cognitive/emotional scale is identical to the scale of the same name in the revised ASHS.

^b Corrected Cohen's *d* effect sizes, with 0.20, 0.50, and 0.80 indicating small, medium, and large effect sizes, respectively [27,28]. Positive effect sizes indicate better sleep hygiene practices for the treatment group.

* *P* < 0.05.

** *P* < 0.01.

****P* < 0.001.

the studied behavior in adolescents might contribute to the skewness of most of these items. Furthermore, as Streiner [36] pointed out, Cronbach's α is likely to be low for scales that contain causal indicators (i.e., items that measure what is defined in the item, instead of measuring an underlying hypothetical psychological construct, or effect indicators) as these items tend to measure concrete activities which may be independent of each other. This is the case in the ASHS for the conceptual scales 'sleep environment' and 'physiological', so Cronbach's α was expected to be low here.

Evidence for the concurrent validity of the ASHS was provided by the significant correlations between scores on the ASHS and several sleep-related variables and variables of daily functioning, of which the association with sleep hygiene had been demonstrated [1,3,4,6,7]. Consistent with the expectations based on previous studies, higher ASHS total scores were associated with higher sleep quality scores and longer sleep duration. Furthermore, the hypothesis that adolescents scoring higher on the ASHS report less chronic sleep reduction, irritability, and daytime sleepiness was also confirmed. These findings support the expectations and strengthen the evidence that the Dutch ASHS indeed measures the construct sleep hygiene.

The important role of cognitive and emotional aspects of sleep hygiene in sleep quality [1,3,6] was also demonstrated in the present study. The cognitive and the emotional conceptual domains appeared to correlate with all measures of sleep quality, whereas other domains were not or were hardly associated with sleep quality. The strongest correlation ($r = 0.38$ – 0.41) with sleep quality, however, was found for the domain that consisted of items about both emotional and cognitive aspects of sleep hygiene. Storfer-Isser et al. [6] also found similar associations between this cognitive/emotional scale and sleep duration and sleepiness. Because they did not examine subjective sleep quality, we cannot conclude whether the Dutch results are in agreement with American data in this respect. Based on the study of Storfer-Isser et al. and on the present study, it can be concluded that creation of the cognitive/emotional scale minimizes the need to present the individual cognitive and emotional scales.

The validity of the Dutch translation of the ASHS was further strengthened by its capability to discriminate between adolescents with insomnia and normal sleepers. Strikingly, the results indicated that adolescents with insomnia score worse than do normal sleepers on those particular aspects of sleep hygiene that have

been demonstrated to be especially important for adolescents with insomnia: the emotional domain, the cognitive domain, and the sleep stability domain. The importance of sleep stability has been noted previously by other authors [5,37] and has been demonstrated in the current study by its significant positive correlations with sleep quality. When 'normal sleepers' were divided into poor sleepers (without a diagnosis of insomnia) and good sleepers, adolescents with insomnia appeared to differ only from the good sleepers on the emotional and cognitive aspects of sleep hygiene but not from poor sleepers. This finding confirms the underlying assumption that worse sleep hygiene contributes to worse sleep. However, the adolescents with insomnia appeared to be differentiated from the poor sleepers without a diagnosis of insomnia by engaging in a stronger bedtime routine. This can be explained by the notion that adolescents with insomnia might also be more aware of the relationship between their own behavior and sleep, as was previously found in a study with adults by Lacks and Rotert [13]. This finding was further confirmed by the fact that after CBT-I treatment adolescents with insomnia improved on almost all ASHS domains, but not on bedtime routine which presumably has already been optimized by adolescents who experience sleep problems for a longer period of time, such as by those with insomnia. These improvements after treatment for insomnia suggest that sleep hygiene may be an important factor for the outcome of insomnia treatment in adolescents.

Some limitations should be considered. First, all data were gathered through self-report and might be affected by common method variance. However, common method variance might not play a big role in our study, because the questionnaires are completed at different times and so the influence of mood and expectations might be reduced [38]. Second, questions about test–retest reliability remain unanswered. Finally, the community sample in this study (adolescents visiting a school for higher education) might not be representative for the whole population. Therefore, future research should also include adolescents from a lower educational level to examine the reliability of the ASHS domains.

The aim of this study was to examine psychometric properties and clinical relevance of the ASHS in adolescents. The findings clearly suggest that the Dutch Adolescent Sleep Hygiene Scale is a valid measure of sleep hygiene. Except for the total scale and the cognitive/emotional domain, the reliability of the ASHS in the present study is not sufficient. However, low reliability can be explained by the fact that several scales can be seen as indexes

instead of psychological constructs [38]. Thus the clinical relevance of the domains might be high in individual screening. The results show strong correlations of the ASHS (domains) with sleep quality and sleep duration and a good capability to discriminate between adolescents with insomnia and good sleepers, and between sleep hygiene before and after treatment for insomnia. This study therefore contributes to a better insight into the validity of the ASHS internationally [39] and into the applicability of sleep hygiene practices in adolescents with and without insomnia [16].

Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: <http://dx.doi.org/10.1016/j.sleep.2014.03.015>.

Appendix A. 1. Adolescent Sleep Hygiene Scale (ASHS) domains and items

Physiological

- After 18:00, I have drinks with caffeine (for example: cola, pop, root beer, iced tea, coffee).
- During the 1 h before bedtime, I am very active (for example: playing outside, running, wrestling).
- During the 1 h before bedtime, I drink four glasses of water (or some other liquid).
- I go to bed with a stomach ache.
- I go to bed feeling hungry.

Cognitive

- During the 1 h before bedtime, I do things that make me feel very awake (for example: playing video games, watching television, talking on the telephone).
- I go to bed and do things in my bed that keep me awake (for example: watching television, reading). I go to bed and think about things I need to do.
- I go to bed and replay the day's events over and over in my mind.
- I use my bed for things other than sleep (for example: talking on the telephone, watching television, playing video games, doing homework).
- I check my clock several times during the night.

Emotional

- During the 1 h before bedtime, things happen that make me feel strong emotions (sadness, anger, excitement).
- I go to bed feeling upset.^a
- I go to bed and worry about things happening at home or at school.

Sleep environment

- I fall asleep while listening to loud music.^a
- I fall asleep while watching television.^a
- I fall asleep in a brightly lit room (for example, the overhead light is on).^a
- I fall asleep in a room that feels too hot or too cold.

Daytime sleep

- During the day I take a nap that lasts 1 h.^a

Substances

- After 18:00, I smoke or chew tobacco.^a
- After 18:00, I drink beer (or other drinks with alcohol).^a

Bedtime routine

- I use a bedtime routine (for example, bathing, brushing teeth, reading).

Bed/bedroom sharing

- I sleep alone.
- I sleep all or part of the night with someone else [for example, with your parent(s), sister, or brother].^a

Sleep stability

- During the school week, I stay up at least 1 h past my usual bedtime.
- During the school week, I 'sleep in' at least 1 h past my usual wake time.^a
- On weekends, I stay up at least 1 h past my usual bedtime.^a
- On weekends, I 'sleep in' at least 1 h past my usual wake time.^a

Source: LeBourgeois et al. [1].

^aItems are skewed in the Dutch translation of the ASHS in the present study.

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